

7301-EN-01

DTIC

U of Bristol.

**DEVELOPMENT OF AN INUNDATION MAPPING CAPABILITY USING
HIGH RESOLUTION FINITE ELEMENT MODELLING**

by

C. SMITH, P.D. BATES AND M.G. ANDERSON

DISTRIBUTION STATEMENT A

**Approved for public release
Distribution Unlimited**

Interim Report 005
December 1995

United States Army

European Research Office of the U.S. Army
London, England

CONTRACT NUMBER N681710-94-C-9109

Professor M G Anderson

Approved for Public Release: distribution unlimited.

19960226 092

PDF QUALITY IMPROVED

MISSOURI RIVER FLOOD MODELLING PROJECT

Report no. 5:

Professor Malcolm G. Anderson

*Department of Geography, University of Bristol, University Road, Bristol, BS8 1SS,
UK. Tel: +44-117-929-7875 Fax: +44-117-928-7878*

SUMMARY

This document reports results derived from dynamic simulations computed with a two dimensional finite element model of a 60 km reach of the Missouri River.

Research is currently being undertaken in several areas regarding refinements for model application which are directly relevant to the Missouri River model. These involve calibration, parameterization, boundary conditions and topography. These are all looked at very briefly in this report.

i) Calibration

Calibration of the hydraulic model is usually attained by comparison of a simulated outflow hydrograph to an observed one. This is however not an ideal situation when using a large 2D distributed model where the outflow hydrograph is one of many output variables from the model. There are several possible improvements to this scheme currently under consideration. What is required is one or more measurable variables, from both model and observation, within the model domain. Any such variable would give the calibration much greater strength as the internal model response, the primary result of concern, would then become the direct target of the calibration procedure rather than a secondary factor expected to slot into place if the outflow is satisfactory. There are three obvious choices for such a variable, these being inundation extent, velocities and stage values. For the Missouri model inundation extent is not very proficient as the model covers only in channel flows and therefore the inundation variability is tiny. Measured velocities could be used if that data were available but that is not the case at present. Measured stage values at a point in the domain are however available for the Missouri model. The stage measurements at Yankton and Gayville are within the model domain and are of good quality. Internal stage measurements are therefore being developed at present for model calibration on the Missouri.

Some modifications to the computer code of the hydraulic model allow the water surface elevation at the node corresponding to the gauge site to be written out at whatever time interval is required. This modelled value can then be directly compared to the measured stage values at the same point in time and space. Thus adding the extra credibility to the calibration. The modifications to the computer code have recently been completed and the system is now in a trial period. Preliminary indications are encouraging but it seems the modelled free surface values are highly dependant on the bed topography, as might be expected. Until additional topographic improvements can be made to the model it will

continually perform below its absolute potential and thus thwart possible improvements from an enhanced calibration scheme.

ii) Parameterization of the model

This is a crucial area of model application. In large scale applications bed friction is the dominant parameter. This is usually assigned a fixed value for each node for the duration of a simulation. This rigid representation of bed friction is possibly an over simplification, limiting model performance.

There is evidence suggesting that bed friction varies with flow rate and water depth, especially on floodplains. It is a research aim at present to make the friction parameterization dynamic taking these factors into account. Already a simple depth dependence for the friction parameter has shown a marked improvement in the calibration of large flood events on a model of the River Culm in S.W. England (Figure 1).

Further development of this technique will be carried out in the near future during which it shall be applied to the Missouri model. Whether it will have a significant effect on a channel only model, such as the Missouri, is unknown at present but is an important prospect to explore.

iii) Boundary conditions to the model

These have been investigated with regard to their influence on model performance. Results have been obtained for the Missouri model indicating a strong dependence, particularly of velocity profiles, on the upstream and side boundary conditions. These results will be useful in setting up future dynamic runs.

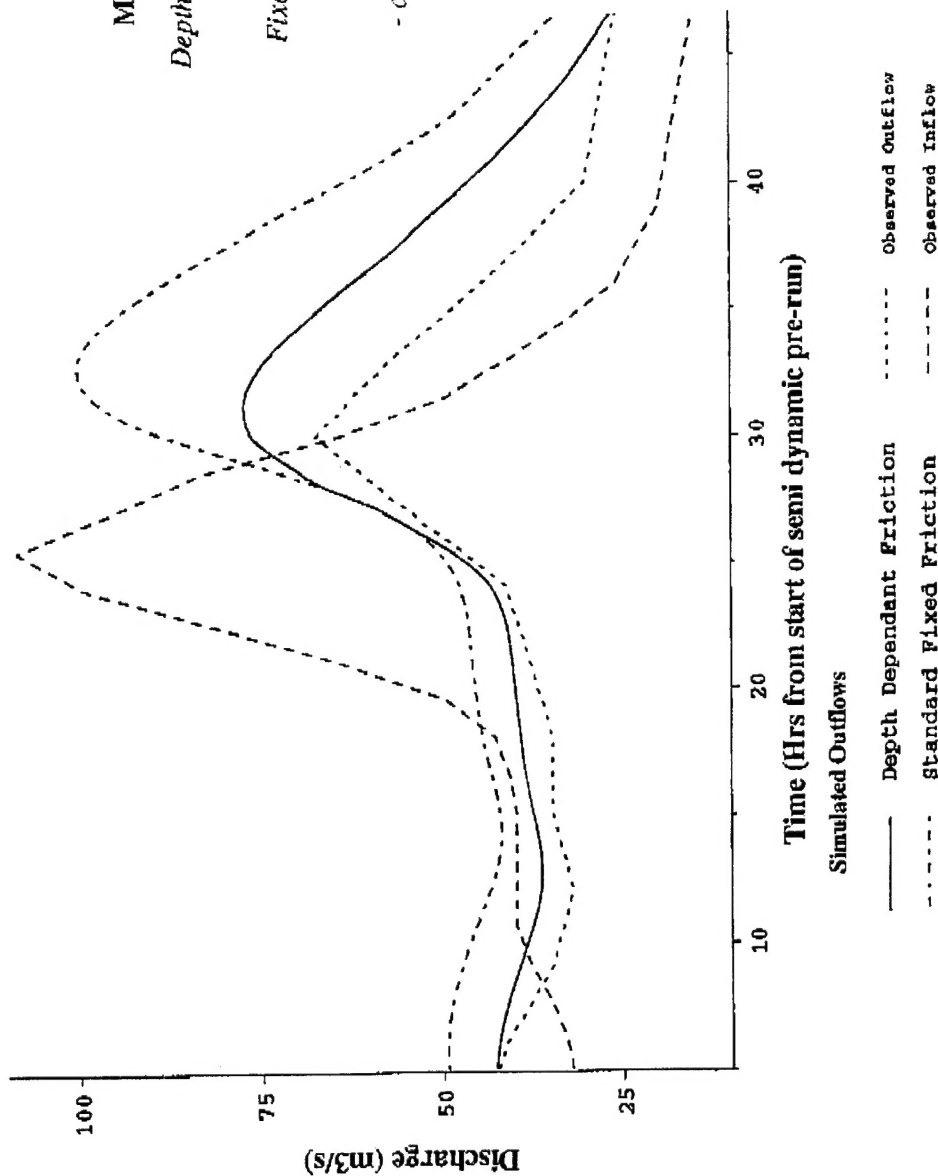
iv) Topographic smoothing

This has been applied to the Missouri model to try to create a more realistic bed topography and improve the performance of the finite element solution technique. The smoothed topography has taken most of the obvious irregularities from the previous version. Whether it is an improvement or not has yet to be assessed.

CONCLUSIONS

Despite the problems with the Missouri model in its present incarnation significant amounts of work have been directed towards application improvements for the model. These are beginning to show beneficial results as have been illustrated in this report and with further development should continue to do so.

River Culm 1 in 5 year event : Comparison Of Outflow Hydrographs From Fixed And Simple Depth Dependant Friction Coefficient



Manning's Friction Coefficients

*Depth Dependant Friction = $1/((H*20)+10)$*

*Fixed Friction = 0.0833 for floodplain
0.025 for channel
0.0166 for mill race*

- commonly used values for this reach